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Kodak
Professional Notes

For Registered Owners of:
Kodak Color, Industrial, and Professional Handbooks

KEYS TO COLOR PRINTING

Part II (EXPOSURE)

EXPOSURE? Simple, you say—thinking in terms of previous black-and-white printing experience: Exposure is a function of both time and intensity. In contact printing, the intensity is usually fixed and only the time is changed. In enlarging, both time and intensity can be varied. For example, a change of one stop in exposure (a factor of two) adjusts for a density change of 0.3 in the film being printed. Such a change can also be made by increasing the exposure time 100 percent or decreasing it by 50 percent.

But now we leap from this simple platform into the deeper waters of color photography! The exposure latitude for color-printing materials is extremely critical. No compensation for exposure errors can be made during processing, as can be done with black-and-white printing materials, and, furthermore, small errors in density are readily noticeable. Thus, color printing requires that we delve into exposure matters a little more thoroughly. Of course, the same black-and-white principles apply in that a change in time, intensity, or both may be used to expose color-printing materials. All modern color-print materials contain three sensitive layers, however, and it is rarely possible that each of these three sensitive layers will have identical speeds. It is therefore necessary to control the exposure of each of these three layers independently. Kodak Color Compensating Filters are manufactured for the purpose of controlling one or more of the colors of light to which these three layers respond. This is, of course, a type of intensity control.

Although an enlarger may be equipped with a white light source, such as a tungsten lamp, it may be more convenient to think of this source as consisting of three lamps—red, green, and blue. The CC Filters, then, are used to control the intensities of one or two of these "three sources" simultaneously.

As an example, let's assume that we are using a color-print material with a blue-sensitive layer which is two times as fast as the red- and green-sensitive layers. If uniform white light is used to expose this material, the blue-sensitive layer will, therefore, be overexposed by a factor of two times. In this example, a CC-30Y could be used in the exposing

beam to slow down the effective blue speed so that the exposure of the blue layer would be equal to that of the red and green layers.

But how did we happen to choose a 0.3 Color Compensating Filter to do the job in this particular case? In the first paragraph of this article, we noted that a two-times change in effective exposure could be obtained by introducing a 0.3 density. Here, we wanted to affect only the blue exposure, so we chose a yellow filter (absorbing blue light) with a density of 0.3—a CC-30Y Filter.

Color-print exposure adjustments may thus depend on the density of the Color Compensating Filters added to or subtracted from the filter combination. The table below may be helpful in calculating readjusted exposures:

We have space here only to show what happens with yellow filters but, similarly, CC Filters of other colors may be substituted, such as:

Magenta filters control green light
Cyan filters control red light
Red filters control blue and green light
Green filters control red and blue light
Blue filters control green and red light

Since it is often inconvenient to estimate fractional stops accurately on a lens diaphragm, it is usually far more practical to change the time rather than the intensity. Incidentally, this time change is very easily calculated by the use of a Kodak Dye Transfer Dataguide (sold by Kodak dealers for $1.00) which can be used to plot density units against a time scale.

Naturally, with a white light modified by CC Filters, a change in time changes the exposure in all three sensitive layers simultaneously. Similarly, a change in intensity, such as changing the *f*- stop, will also change the exposure in all three sensitive layers simultaneously.

So much for general principles—are you still with us?

Type R Color-Printing Material

In printing Kodak Color Print Material, Type R, which is a reversal color-print material designed to yield prints by either contact or enlargement from positive color transparencies, it is necessary to control the relative exposures of the three (red, green, and blue) sensitive layers. This can be done with Kodak Color Compensating Filters.

It can be seen from the table below that the number of the filter indicates the density of the filter. This, in turn, is the intensity control the photographer has for one or more colors of the exposing light. Note that the addition of a yellow CC Filter, for example, cuts down on the exposure of the blue-sensitive layer. Therefore, less of the silver halide is exposed and subsequently developed in the first developer of the processing solutions. This, then, leaves more silver halide to be developed in the color-developer stage and produces more yellow dye in this layer. From this we can

Kodak Color Compensating Filters		Density Unit		Effect in f/ Stop	Time Change (in percent)
CC-10Y	=	.10	=	⅓ stop less blue light	33
CC-20Y	=	.20	=	⅔ stop less blue light	66
CC-30Y	=	.30	=	1 stop less blue light	100
CC-40Y	=	.40	=	1⅓ stops less blue light	133
CC-50Y	=	.50	=	1⅔ stops less blue light	166
CC-60Y*	=	.60	=	2 stops less blue light	200
CC-70Y*	=	.70	=	2⅓ stops less blue light	233
CC-80Y*	=	.80	=	2⅔ stops less blue light	266
CC-90Y*	=	.90	=	3 stops less blue light	300

*A combination of two filters

establish a good rule of thumb for Type R printing: Add a filter of the color that you want the print to become.

Type C Color-Printing Material

The recommended technique for exposing Kodak Color Print Material, Type C, from Kodacolor or Kodak Ektacolor negatives is to use red, green, and blue light, rather than a white light source whose red, green, and blue components are controlled by Color Compensating Filters. The exposure in any one of the three layers is, of course, still a function of intensity and time. For example, the red-sensitive layer is exposed independently of the green and blue layers. To control the intensity of the red light, a variable transformer or a rheostat can be used.

The Kodak Color Conversion Kit, Type C, is a semiautomatic device designed for use with Kodak Auto-Focus Enlargers. It allows the photographer to control the intensity of the red, green, and blue exposures. A photometer, which is part of the equipment, allows accurate measurement of the intensity in terms of density units. Three individual timers are also incorporated into the kit for the control of the red, green, and blue exposure times.

Acceptable Type C prints can also be made by using a fixed intensity as, for example, line voltage (or better, a voltage-regulating transformer) on the enlarging lamp. With fixed intensities of the red, blue, and green exposures, the time will then have to be the variable factor under control of the photographer. One timer can be used, provided that it can be readjusted in the dark to a different setting for each of the three separate red, blue, and green exposures, since they are never alike.

It should also be noted (see Professional Notes No. 4, 1955) that, under certain conditions, Type C prints can be made with white-light exposures controlled by Color Compensating Filters.

To help clarify this concept of color-print exposure and color-balance readjustments, we have devised the following system of diagramming. Each of these diagrams represents a test print and the amount that the colors have deviated from the optimum. This same system can, of course, be used to diagnose your own test color prints and indicate the remedial procedure for correcting exposure and balance. Remember that any CC Filter has twice the corrective effect with Type C Color Print Material that it has with Type R Color Print Material.

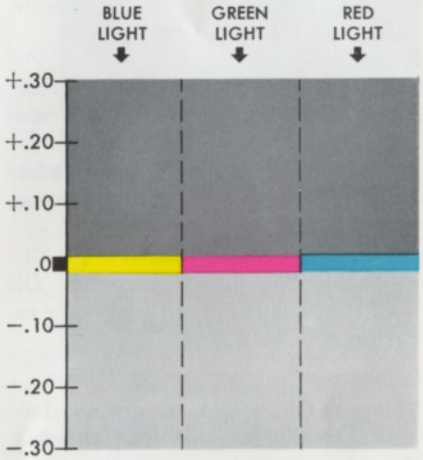


Diagram No. 1

The diagram above represents a perfect color print in which the yellow, magenta, and cyan print densities are in exact balance with each other and, consequently, do not require any exposure adjustment. The dark, shaded area above the 0, or "optimum" line, represents the area of excessive density; the lightly shaded area beneath the 0 line represents the area of insufficient density.

Here is a print (No. 2) which is in perfect color balance because there are equal amounts (in neutral subject areas) of density in each of the three emulsion layers. However, this test print will look too dark by .10 in neutral density because it has +.10Y, +.10M, and +.10C. Thus, only an exposure adjustment is needed to make this an ideal print as illustrated in Diagram No. 1. A Type R print would need *more* exposure (.10 density units increase); a Type C print would need *less* exposure (.05 density units decrease).

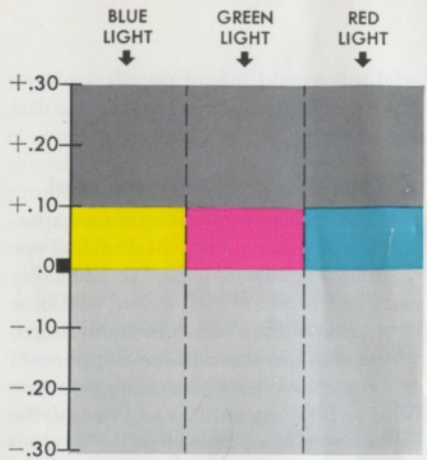


Diagram No. 2

This print (No. 3) looks too cyan. The amount has been determined by viewing the print through a CC-20R Filter. (See CC Filter article in No. 4 issue, 1955, Kodak Professional Notes.)
Remedy:

—*For a Type C Print exposed with blue, green, and red light:* Decrease the red-light exposure by .10 (⅓ stop).

—*For a Type C Print exposed with white light:* Add a CC-10C Filter. No change in exposure.

—*For a Type R Print:* Remove the CC-20C Filter. No change in exposure. OR Add a CC-20R Filter. Increase the exposure by .20 (⅔ stop).

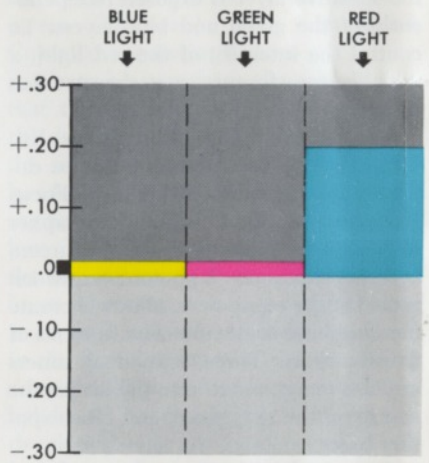


Diagram No. 3

This print (No. 4) looks too green and too light. Actually, magenta dye is deficient.
Remedy:

—*For a Type C Print exposed with blue, green, and red light:* Increase the green-light exposure by .10 (⅓ stop).

—*For a Type C Print exposed with white light:* Remove the CC-10M Filter. No change in exposure. OR
If no CC-10M Filter is already present, add a CC-10G. Increase exposure by .10 (⅓ stop).

—*For a Type R Print:* Add a CC-20M Filter. No change in exposure.

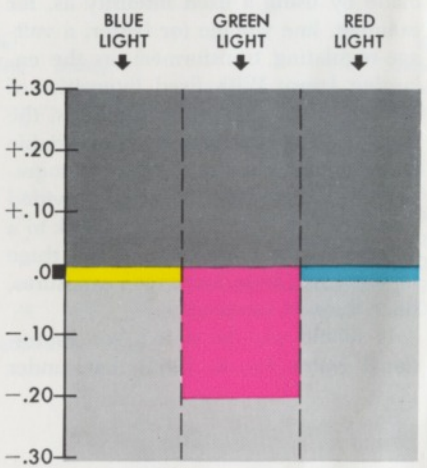


Diagram No. 4

This test print (No. 5) looks too yellow and too light in the shadow areas. Close inspection reveals that too much yellow dye is present and not enough magenta and cyan dye.

Remedy:

—*For a Type C Print exposed with blue, green, and red light:* Decrease the blue-light exposure by .10 (⅓ stop) and increase the red-light and green-light exposures by .10 (⅓ stop).

—*For a Type C Print exposed with white light:* Add a CC-20Y Filter. If no change in exposure is made, this would bring the yellow density down to the —.20 density line as shown in Diagram 5a, below.

Alternate Steps in the Solution of Diagram No. 5

In Diagram No. 5a, the print would be in correct color balance but too light by .20. The exposure, therefore, would have to be increased by .10 (⅓ stop) to bring all three colors up to the optimum density line. OR

Alternatively, this same problem can be solved by adding a CC-10Y Filter and removing the CC-10M + CC-10C, provided that these magenta and cyan filters were used in the combination for making the test print.

—*For Type R Print:*

Remove the CC-40Y Filter. This would bring the yellow print density down to that of the cyan and magenta, as shown in Diagram No. 5a. The exposure should then be decreased by .20 (⅔ stop), which will bring all three color densities up to the optimum density level. OR

Alternatively, the correction can be accomplished by adding a CC-40B Filter which would, in effect, do this: With the balance thus corrected, the exposure should then be increased by .20 (⅔ stop) to bring all colors down to the optimum density line.

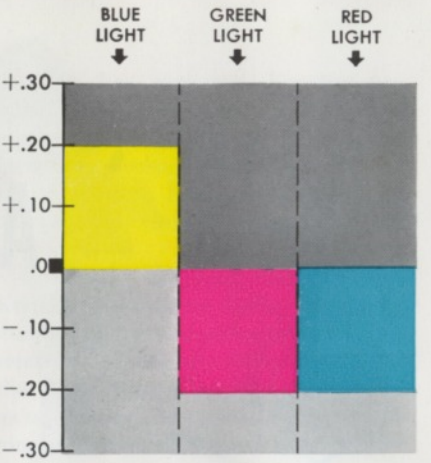


Diagram No. 5

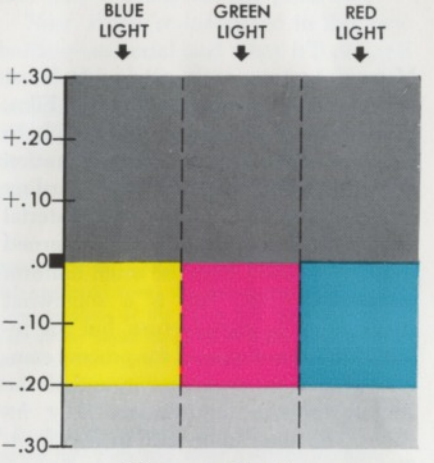


Diagram No. 5a

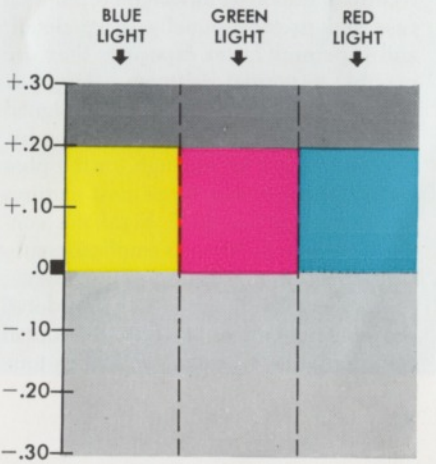


Diagram No. 5b

Meet AUTOSCREEN

MODERN LITHOGRAPHY gets a new boost with Kodalith Autoscreen Ortho Film. From picture scene or photograph to halftone negative is a simple operation with this Kodalith material. A startling innovation in film making, this material has across its emulsion a dot-patterned sensitivity rather than the usual uniform sensitivity. True, this is a somewhat tricky thing to manufacture, but the result eliminates the need for process cameras, glass or contact screens, and all the acutely precise adjustments they involve. The film can be used in any sheet-film camera—a view camera is fine; it records outdoor or indoor pictures with ease and in exceptionally sharp detail; and it permits faster exposures than are possible in normal halftone making.

Autoscreen Ortho Film was designed primarily for use in photolithography. Its contrast is a bit too high for the photoengraving process. Since most pictures are enhanced by good highlight contrast, the film is made to emphasize subtle nuances in highlight areas.

Another advantage is the fine detail the film reproduces. In fact, this detail is so sharp that type *and* continuous-tone matter can be exposed *together* on the film *with no loss of legibility in the type*.

Autoscreen Ortho Film is intended primarily for copying work—copying with just a view camera and photofloods, that is. There's no need for arc lamps. And, the film can be used as well for studio-setup shots. It's ideal for quick halftone negatives of small items to illustrate a company catalogue or parts list. When we introduced this film, we admittedly didn't intend it for outdoor use with sunlight, though it is usable outdoors in a limited fashion such as architectural photography. Of course, you can't become a press photographer merely by using this film in daylight, because we neither sanction its use with flash bulbs nor recommend exposures much less than one second. But wherever it's applied, Autoscreen Ortho Film has the distinct advantage of automatically becoming a halftone negative when it's developed.

At present, the film is available in only two sizes—8 by 10 and 11 by 14 inches. You can cut these sheets, of course, to fit 4 by 5- and 5 by 7-inch sheet-film cameras, respectively.

Because of the film's simplicity in use and its need for only normal photographic equipment, halftones for offset printing can be made quickly and economically by industrial photographers. The film is developed (in Kodalith Developer), fixed, and dried in a matter of a few minutes. By installing the Autoscreen halftone method, firms using Multilith, Davidson, or other offset duplicators can make much more extensive use of pictures in everything coming off their presses.

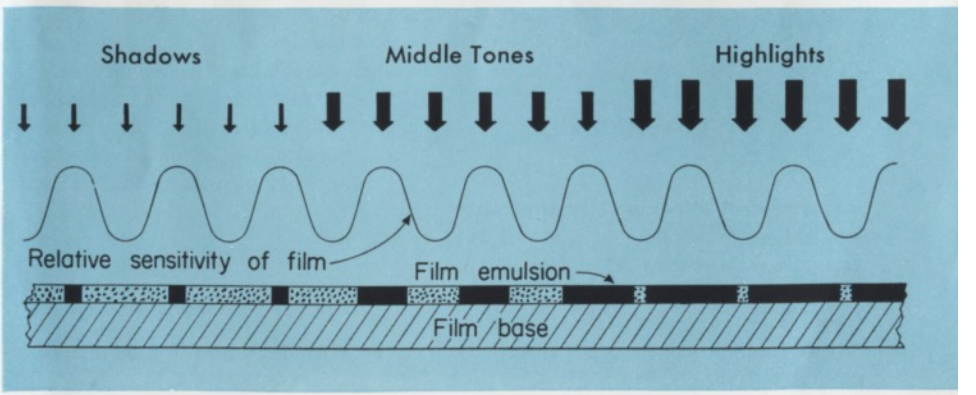
Pictures have invaluable functions in engineering reports, house organs, progress reports, company newspapers, promotional literature, et al. And since halftone negatives for multiple offset reproduction are now made so easily and economically with Autoscreen Ortho Film, it should precipitate a boom in business and industrial picture applications.

In the field of drawing reproduction, the film has uses, too. For instance, when photos of models or equipment are used as drawings, it provides the means for mechanically reproducing the drawings—even lines and lettering are outstandingly clear on Autoscreen Ortho negatives.

Eminently adaptable for use with Kodalith Autoscreen Ortho Film are a number of commercially prepared, presensitized offset plates. These plates, like the film, require no elaborate equipment; they can be exposed with the halftone negative, developed quickly (say, a couple of minutes for the operation), and they're ready for the press run.

Now, if you're interested in this new halftone material and what it'll do, and if you already haven't received a copy, our booklet, "Kodalith Autoscreen Ortho Film," is available gratis by writing Sales Service Division, Eastman Kodak Company, Rochester 4, New York.

The sensitivity of Kodalith Autoscreen Ortho Film is varied across its entire emulsion surface in the form of a dot pattern. In this sectional view, the dot-patterned sensitivity of the film is shown as a wave in which top portions of the curve are acutely sensitive to light, while the bottom areas are least sensitive. Small amounts of light, such as from the shadow areas of the subject, expose only the most sensitive areas of the film. On the other hand, the large amount of light from highlight areas exposes all but the least sensitive portions of the emulsion. The result: a halftone negative without using a glass or contact screen. And because no screen lessens the intensity of light striking the film, Autoscreen Ortho Film boasts shorter exposure time than any other halftone method.



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